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# Detection of quasi-periodic processes in complex systems: How do we quantitatively describe their properties?

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## Abstract

It has been shown that in reality at least two general scenarios of data structuring are possible: a a self-similar SS scenario when the measured data form an SS structure and b a quasi-periodic QP scenario when the repeated strongly correlated data form random sequences that are almost periodic with respect to each other. In the second case it becomes possible to describe their behavior and express a part of their randomness quantitatively in terms of the deterministic amplitude-frequency response belonging to the generalized Prony spectrum. This possibility allows us to re-examine the conventional concept of measurements and opens a new way for the description of a wide set of different data. In particular, it concerns different complex systems when the 'best-fit' model pretending to be the description of the data measured is absent but the barest necessity of description of these data in terms of the reduced number of quantitative parameters exists. The possibilities of the proposed approach and detection algorithm of the QP processes were demonstrated on actual data: spectroscopic data recorded for pure water and acoustic data for a test hole. The suggested methodology allows revising the accepted classification of different incommensurable and self-affine spatial structures and finding accurate interpretation of the generalized Prony spectroscopy that includes the Fourier spectroscopy as a partial case. © 2014 The Royal Swedish Academy of Sciences.

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## Keywords

complex systems, quasi-periodic process, random data processing, the generalized Prony spectrum